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Empirical Estimation of Default and Asset Correlation of Large Corporates and Banks in India

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Abstract

Estimation of default and asset correlation is crucial for banks to manage and measure portfolio credit risk. This would require studying the risk profile of the banks' entire credit portfolio and developing the appropriate methodology for the estimation of default dependence. Measurement and management of correlation risk in the credit portfolio of banks has also become an important area of concern for bank regulators worldwide. The BCBS (2006) has specifically included an asset correlation factor in the computation of credit risk capital requirement by banks adopting the Internal Ratings Based Approach. We estimate default correlation in the credit portfolio of banks. These correlation estimates will help the regulator in India to understand the linkage between bank's portfolio default risks with the systematic factors. We also derive default and asset correlations of Indian corporate and compare it with global scenario. The work tries to find the relationship of the correlation to the default probability as specified by the Basel committee. The findings of this paper could be used further in estimating portfolio credit risk, economic capital and risk adjusted returns on economic capital for large corporate exposures of banks.

Key Words: Default Correlation, Asset Correlation, Credit Portfolio Risk

JEL Classification: G21, G32, C15

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1. Introduction.

Portfolio risk is that loss which arises due to holding two or more assets in the portfolio. When two or more borrowers default simultaneously, the losses are more severe. The higher the correlation of default, the greater is the concentration portfolio risk. The lower the correlation of default more diversified the portfolio. The critical element in successfully managing a credit risk portfolio is that we must manage the dynamics of default or asset correlation risk. A portfolio approach to credit risk analysis allows portfolio managers to quantify and stress test concentration risk along various dimensions.

Correlation describes the extent to which loans tend to default at the same time. Intuitively, we would expect that companies would have some tendency to default together. This joint dependence could happen if the whole economy is in recession or in distress; forcing many companies into bankruptcy at the same time, or it could be that the default of one company triggers the default of another company. For example, the collapse of a car factory would tend to push suppliers and businesses in the local town closer to default. Correlation also exists between companies in different industries that rely on the same production inputs (e.g Car Manufacturing co. is using Tire) and among companies that rely on the same geographical market (Diamond traders and Textiles firms located in Gujarat region in India or IT firms serving the North American market). When correlations are significant, they produce loss distributions that are highly skewed (tail measures of credit risk like value at risk captures this).

Modeling credit quality correlation and default correlation is therefore crucial for banks to manage and measure portfolio credit risk. This would require studying the risk profile of the banks' entire credit portfolio and developing the appropriate methodology for the estimation of default dependence. Measurement and management of correlation risk in the credit portfolio of banks has also become an important area of concern for bank regulators worldwide. The BCBS (2006) has specifically included an asset correlation factor in the computation of credit risk capital requirement by banks adopting the Internal Ratings Based Approach.

Internationally, several methodologies have been developed to estimate default correlation and several authors have documented the relationship between the initial credit quality of the portfolio and the default and asset correlation for commercial portfolios. The

structural model approach uses equity correlation as a proxy for asset correlation. This approach is based on the work by Merton (1974), according to which loan default occurs when the market value of the firms' assets falls below the book value of debt. Thus the default correlation between two borrowers is constructed with the use of the correlation of the borrower's asset returns (derived from equity returns) and the normal inverse to the distance to default. De Servigny and Renault (2002) use a sample of 1101 firms from S&P's 12 industry categories and calculate average equity correlations across and within industries over the period 1980-2001.

Bluhm and Overbeck (2003) have deduced a methodology for estimation of asset correlations based on the volatility of default rates time series. Using Moody's bond default data from 1970 to 2001 they derive grade-wise implicit asset correlation of US corporates. They empirically observed that their estimated asset correlation is in line with Basel II prescribed asset correlation for corporates.

Lopez (2004) has used the structural model framework to empirically derive asset correlation for portfolios. His paper demonstrates that asset correlation for relatively highly rated, large sized companies is high. According to his explanation, this relationship arises because high credit quality firms are more likely to be influenced by common macro-economic conditions. On the other hand, asset correlation for poor credit quality, large sized companies are low because defaults of such firms are subject to firm-specific problems. This is also the relationship which is highlighted by BCBS (2006) wherein, in the credit risk capital estimation formula for large corporate exposures, asset correlation is a decreasing function of probability of default. Bandyopadhyay, Saha and Chherawala (2007) use the approach developed by Lucas (1995) to establish a linkage between rating wise PD and Default Correlation amongst Indian corporates.

We estimate default correlation in the credit portfolio of banks as well as for rated corporates in India. These correlation estimates will help the regulator in India to understand the linkage between bank's portfolio default risks with the systematic factors. We also derive asset correlations of Indian corporate and compare it with global scenario. The work tries to find the relationship of the correlation to the default probability as specified by the Basel committee. This paper demonstrates that default correlation is positively related to the default probability of firms. The findings of this paper could be used further in estimating portfolio

credit risk, economic capital and risk adjusted returns on economic capital for large corporate exposures of banks.

This paper is organized as follows. Next section describes the data used in the study and methodology followed by us. Section 3 discusses the results and their interpretation. The final section 4 addresses the major conclusions of the paper.

2. Data and Methodology

The first part of this project that deals with default correlation in the credit portfolio of 15 major banks on India is based on the Non Performing Assets (NPA) movements' data on individual banks. The bank level advances and NPA data was taken from Centre for Monitoring Indian Economy (CMIE) Prowess. Here we use single default correlation on the banks. The second part of the paper deals with estimating the default and asset correlation on Indian corporate rating wise. We have used CRISIL's published yearly bond rating data of 572 large corporates and studied their historical rating migration pattern from 1993 to 2009. Both default and asset correlation has been estimated for Moody's one-year default rates (1970-2008).

The methodology has been described below:

Consider a simple case of a portfolio of 2 loans. The unexpected loss (UL) for this portfolio is given by the variance equation:

$$UL_P^2 = \rho_{11} UL_1^2 + \rho_{22} UL_2^2 + 2\rho_{11} UL_1 UL_2$$

Unexpected loss (loss volatility) of a loan can be expressed as:

$$UL_i = \overline{EAD} \times \overline{LGD} \times \sqrt{PD \times (1 - PD)}$$

Where, $\overline{EAD}$ is the average exposure at default, LGD is the average loss given default and PD is the probability of default.

If we consider a large number of loans in the pool, we can the portfolio UL_p will be:

$$UL_P^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} \rho_{ij} UL_i UL_j \qquad (1)$$

We can get an estimate for the correlation of default if we assume that the correlation between each loan is identical (i.e. $\rho_{ij} = \rho$):

$$UL_P^2 = \sum_{i=1}^{N}\sum_{j=1}^{N} \rho_{ij} UL_i UL_j$$

$$= \rho \sum_{i=1}^{N}\sum_{j=1}^{N} UL_i UL_j$$

Assuming each loan has the same UL (i.e. $UL_i=UL_j$), we can estimate the correlation as follows:

$$\rho = \frac{UL_P^2}{(N \times \overline{UL}^2)} \qquad (2)$$

Thus, using this concept, we have calculated the default correlation in the credit portfolio of 15 Indian banks. This correlation is a measure for the sensitivity of the Bank's incremental risk of default of loans to the systematic factors which represents the state of the economy.

We apply the same methodology to calculate the default correlation of Moody's one-year default rates and to the rating wise data of Indian corporate. These correlations measure the sensitivity of the rating grade's PD to the macro economic (or systematic) factors.

An alternative approach to deriving empirical default correlations is proposed by Gordy and Heitfield (2002) using a factor model of credit risk. Credit Metrics (1997), Crouhy et al. (2000) and Zhang et al. of MKMV (2008) derive asset return correlations from a structural model which links correlations to fundamental factors. Our next step is to calculate the asset correlation within each rating in the global as well as national data. For this we used the variance equation given by Bluhm, Overbeck & Wagner (2003, Basel II Handbook) derived from a factor model:

Variance of conditional default rates *g(y)* is expressed by:

$$V[g(y)] = JDP(PD, \rho) - PD \times PD \qquad (3)$$

Where, PD = mean value of time series

Variance = sample variance of time series of observations of default rates

ρ= default rate volatility implied asset correlation

JDP is the joint default probability of two obligors in a uniform portfolio with parameters probability of default PD and implicit asset correlation ρ.

The one factor risk model uses the computation of the asset correlation following the Merton Model. In this, a default event occurs if the firm value of obligor i crosses the default

threshold. The default of an obligor is driven by a latent variable which is a function of a systematic factor and a firm specific idiosyncratic factor.

We start by assuming that the normalized asset return R_t of a firm i in the credit portfolio is driven by common macro factor y and an idiosyncratic factor ε_i.
Therefore, the asset returns at a chosen horizon (say 1 year) can be written as:

$$R_i = \sqrt{\rho_i}\, y + \sqrt{1-\rho}_i \varepsilon_i \qquad (4)$$

$$y \overset{i.i.d}{\sim} N(0,1);\ \varepsilon_i \overset{i.i.d}{\sim} N(0,1)$$

R_i is the implicit return on firm's asset that is driving default migration.

$$\text{var}(y) = \text{var}(\varepsilon_i) = \text{var}(R_i) = 1 \,\forall i$$

Strong sensitivity to the systematic factor implicates a higher correlation of the borrower and higher volatility of the default rates. Note that default correlation and asset correlation are not the same. Default correlation estimate is much lower than the asset correlation.

The implicit asset values of two obligors at the horizon are jointly normally distributed and their JDP follows a bivariate distribution. The joint default probability can therefore be obtained by using the following expression:

$$JDP_{ij} = \Pr[A_i \le K_i, A_j \le K_j) = N(K_i, K_j, \rho)$$

Where, N(.) denotes the cumulative bivariate standard normal distribution of the following form:

$$JDP = \frac{1}{2\pi\sqrt{1-\rho^2}} \int_{-\infty}^{N^{-2}(PD)} \int_{-\infty}^{N^{-2}(PD)} \exp\left[-\frac{1}{2} \frac{x_i^2 - 2\rho x_i x_j + x_j^2}{1-\rho^2} \right] dx_i dx_j \qquad (5)$$

The two upper integration limits refer to the default thresholds (K_i,K_j) for a homogenous portfolio. It is assumed that asset returns are normally distributed a priori. Symbol "ρ" represents the asset correlation between two obligors; x and y are their default thresholds.

We can calculate the asset correlation $\boldsymbol{\rho_a}$ if we already know the JDP by using the following formula:

$$JDP_{ij} = N(K_i, K_j, \rho_a)$$

Where N denotes the cumulative bivariate standard normal distribution

Ki, Kj gives the distance to default

ρ_a is the asset correlation

We calculate JDP using the BIVNOR function such that

$$JDP_{ij} = BIVNOR\ (normsinv(PD_i),\ normsinv(PD_j),\ \rho_a) \qquad (5a)$$

"BIVNOR" is a function that gives the cumulative bivariate standard normal distribution. Gordy used similar measure to calculate JDP. The next step is to estimate implicit asset correlation ρ through iterations.

The JDP value is the key ingredient of the formula expressing the variance of the conditional default rates g(y) as depicted in expression 3.

We estimate the average default rates PD from the historical time series data. V[g(y)] is estimated by the sample variance of the time series of observed default rates. Finally, we substitute these to inputs in equation 3 to obtain the only unknown parameter $\rho=\rho_a$ through optimization method. Thus, solving for ρ yields default rate volatility implied asset correlation ρ_a. This correlation generally captures the changing macro economic scenario (or the systematic factors). Correlation or dependence is captured by the variations in default rates due to macro economic changes. Following this approach, we have estimated rating class wise implicit asset correlation based on Moody's and CRISIL data.

3. Empirical Results and Interpretation

Table 1 shows the PD, LGD and correlation figures of the 15 banks. This table is based on the bank data (NPA movements) as reported in CMIE Prowess. Here we find that Canara bank has the highest default correlation while ICICI bank has the lowest.

Table-1- Default Correlation of Indian banks

BANKS	*PD*	*LGD*	*Portfolio UL*	*Correlation*
Allahabad Bank	1.97%	48.53%	0.49%	0.53%
Andhra Bank	1.12%	44.81%	0.68%	2.07%
Bank of Baroda	1.51%	53.69%	0.74%	1.29%
Bank of India	1.91%	44.10%	0.69%	1.30%
Canara Bank	2.44%	28.08%	1.06%	5.93%
Central Bank of India	2.19%	65.32%	1.06%	1.23%
Corporation Bank	1.06%	58.86%	0.43%	0.52%
Dena Bank	3.14%	43.97%	1.12%	2.14%
HDFC Bank	2.43%	63.99%	1.22%	1.54%
ICICI Bank	1.65%	64.37%	0.42%	0.26%
Indian Overseas Bank	2.64%	42.60%	1.08%	2.49%
Punjab National Bank	1.92%	45.8%	0.53%	0.71%
State Bank of India	2.54%	49.67%	0.74%	0.90%
UCO Bank	2.27%	48.75%	0.79%	1.19%
Union Bank of India	1.73%	56.23%	0.47%	0.41%

The table 2 shows the one-year default rates rating wise for a period 1970-2008. The default and asset correlation has been calculated according to the methodology described in the previous section.

The default correlation calculated increases with increasing default rates and thus it is found to be highest for Caa-C category and lowest for Aaa category. However an interesting point to note here is that A category has lower default correlation than Aa category. According to the data the overall PD of A category is also lower than that of Aa category.

Table-2- Default and Asset Correlation using Moody's one-year default rates

	Aaa	Aa	A	Baa	Ba	B	Caa-C
1970	0.000%	0.000%	0.000%	0.541%	4.264%	19.718%	53.333%
1971	0.000%	0.000%	0.000%	0.000%	0.881%	0.000%	14.286%
1972	0.000%	0.000%	0.000%	0.000%	0.000%	7.273%	37.500%
1973	0.000%	0.000%	0.000%	0.460%	0.000%	3.922%	36.364%
1974	0.000%	0.000%	0.000%	0.000%	0.512%	7.143%	0.000%
1975	0.000%	0.000%	0.000%	0.000%	1.020%	6.154%	0.000%
1976	0.000%	0.000%	0.000%	0.000%	0.985%	0.000%	0.000%
1977	0.000%	0.000%	0.000%	0.291%	0.525%	3.175%	50.000%
1978	0.000%	0.000%	0.000%	0.000%	1.090%	5.556%	0.000%
1979	0.000%	0.000%	0.000%	0.000%	0.494%	0.000%	0.000%
1980	0.000%	0.000%	0.000%	0.000%	0.000%	4.938%	33.333%
1981	0.000%	0.000%	0.000%	0.000%	0.000%	4.494%	0.000%
1982	0.000%	0.000%	0.256%	0.318%	2.783%	2.299%	23.077%
1983	0.000%	0.000%	0.000%	0.000%	0.911%	6.306%	42.105%
1984	0.000%	0.000%	0.000%	0.362%	0.833%	6.780%	100.000%
1985	0.000%	0.000%	0.000%	0.000%	1.413%	7.483%	0.000%
1986	0.000%	0.000%	0.000%	1.347%	2.041%	11.602%	26.667%
1987	0.000%	0.000%	0.000%	0.000%	2.724%	6.154%	20.000%
1988	0.000%	0.000%	0.000%	0.000%	1.258%	6.202%	28.571%
1989	0.000%	0.604%	0.000%	0.594%	3.037%	8.720%	25.000%
1990	0.000%	0.000%	0.000%	0.000%	3.409%	16.616%	58.824%
1991	0.000%	0.000%	0.000%	0.272%	4.892%	12.598%	38.889%
1992	0.000%	0.000%	0.000%	0.000%	0.306%	9.182%	28.571%
1993	0.000%	0.000%	0.000%	0.000%	0.567%	4.517%	26.667%
1994	0.000%	0.000%	0.000%	0.000%	0.242%	4.050%	5.263%
1995	0.000%	0.000%	0.000%	0.000%	0.714%	4.227%	9.091%
1996	0.000%	0.000%	0.000%	0.000%	0.000%	1.366%	13.793%
1997	0.000%	0.000%	0.000%	0.000%	0.188%	1.935%	14.634%
1998	0.000%	0.000%	0.000%	0.118%	0.808%	3.780%	11.255%
1999	0.000%	0.000%	0.000%	0.103%	1.261%	4.967%	18.182%
2000	0.000%	0.000%	0.000%	0.378%	0.859%	5.803%	20.073%
2001	0.000%	0.000%	0.165%	0.191%	1.308%	9.501%	31.474%
2002	0.000%	0.000%	0.166%	1.228%	1.481%	4.574%	28.192%
2003	0.000%	0.000%	0.000%	0.000%	0.955%	2.073%	21.016%
2004	0.000%	0.000%	0.000%	0.000%	0.381%	0.832%	11.485%
2005	0.000%	0.000%	0.000%	0.175%	0.000%	1.224%	6.179%
2006	0.000%	0.000%	0.000%	0.000%	0.181%	1.144%	5.919%
2007	0.000%	0.000%	0.000%	0.000%	0.000%	0.000%	5.873%
2008	0.000%	0.515%	0.333%	0.454%	1.058%	1.985%	14.532%
Overall PD	0.000%	0.029%	0.024%	0.175%	1.112%	5.341%	22.055%
ULP	0.000%	0.125%	0.074%	0.317%	1.192%	4.377%	20.409%
ULT	0.000%	1.694%	1.536%	4.182%	10.488%	22.485%	41.462%
DC	--	0.549%	0.234%	0.574%	1.292%	3.789%	24.230%
JDP	--	0.00017%	0.00006%	0.00131%	0.0266%	0.4768%	9.0296%
AC	--	27%	20%	16%	12%	14%	42%

Note: PD: Long term average Probability of Default; ULP is the portfolio volatility (or unexpected loss); ULT is the total portfolio unexpected loss assuming perfect correlation; DC=Default correlation; JDP: Joint default probability; AC: Implicit Asset correlation.

The asset correlation computed gives us interesting results. While it is still highest for Caa-C category and lowest for Aaa category, the asset correlation for Aa category is higher than that of A, Baa, Ba and B categories.

Table-3- Default Correlation of Indian corporate (rating wise)

	AAA	AA	A	BBB	BB	B	C	IG	NIG
1993	0.00%	0.00%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%
1994	0.00%	0.00%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%
1995	0.00%	0.00%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%
1996	0.00%	0.00%	0.00%	1.85%	20.00%		0.00%	0.47%	16.67%
1997	0.00%	0.00%	2.33%	0.00%	18.18%		0.00%	1.13%	16.67%
1998	0.00%	0.00%	1.54%	0.00%	23.53%	50.00%	50.00%	0.72%	30.43%
1999	0.00%	1.35%	7.21%	18.18%	55.17%	0.00%	50.00%	6.17%	50.00%
2000	0.00%	0.00%	0.00%	5.71%	26.67%	42.86%	57.14%	0.97%	34.09%
2001	0.00%	0.00%	1.69%	8.70%	12.50%	16.67%	50.00%	1.66%	25.00%
2002	0.00%	0.00%	0.00%	11.76%	22.22%	60.00%	33.33%	1.18%	35.00%
2003	0.00%	0.00%	3.70%	0.00%	40.00%	0.00%	66.67%	0.64%	36.36%
2004	0.00%	0.00%	0.00%	14.29%	0.00%	0.00%	0.00%	0.68%	0.00%
2005	0.00%	0.00%	0.00%	0.00%	0.00%		100.0%	0.00%	66.67%
2006	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%
2007	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%
2008	0.00%	0.00%	0.00%	0.00%	100.0%			0.00%	100.00%
2009	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%
Average PD	0.00%	0.08%	0.97%	3.56%	18.72%	24.22%	31.32%	0.80%	24.17%
ULP	--	0.33%	1.94%	5.97%	26.61%	26.17%	33.63%	1.48%	28.32%
ULT	--	2.82%	9.80%	18.53%	39.01%	42.84%	46.38%	8.91%	42.81%
DC	**--**	1.35%	3.93%	10.37%	46.54%	37.32%	52.57%	2.77%	43.75%

In the Indian context too, default correlation increases with increasing default rates. However the default correlation of category B is lower than that of BB category.

Table-4- Asset Correlation of Indian corporate (rating wise)

Rating	Avg PD	Var(PD)	JDP	Implicit AC
IG	1.022%	0.022%	0.032%	18.460%
NIG	31.019%	8.019%	17.640%	57.337%
AAA	0.000%	0.000%	0.000%	0.000%
AA	0.097%	0.001%	0.002%	31.100%
A	1.618%	0.038%	0.064%	16.169%
BBB	3.562%	0.356%	0.483%	34.651%
BB	26.761%	7.082%	14.243%	56.608%
B	29.630%	6.848%	15.628%	51.520%
C	44.681%	11.308%	31.272%	65.955%

Here, we have calculated the asset correlation of the Indian corporate (rating wise) using the variance equation. Here too in general we can say that the asset correlation increases with increasing default rates. However it is not true for A category which shows the lower asset correlation than category AA.

First, let us analyze the default correlation of the banks. The chart below compares the default correlation among the 15 banks

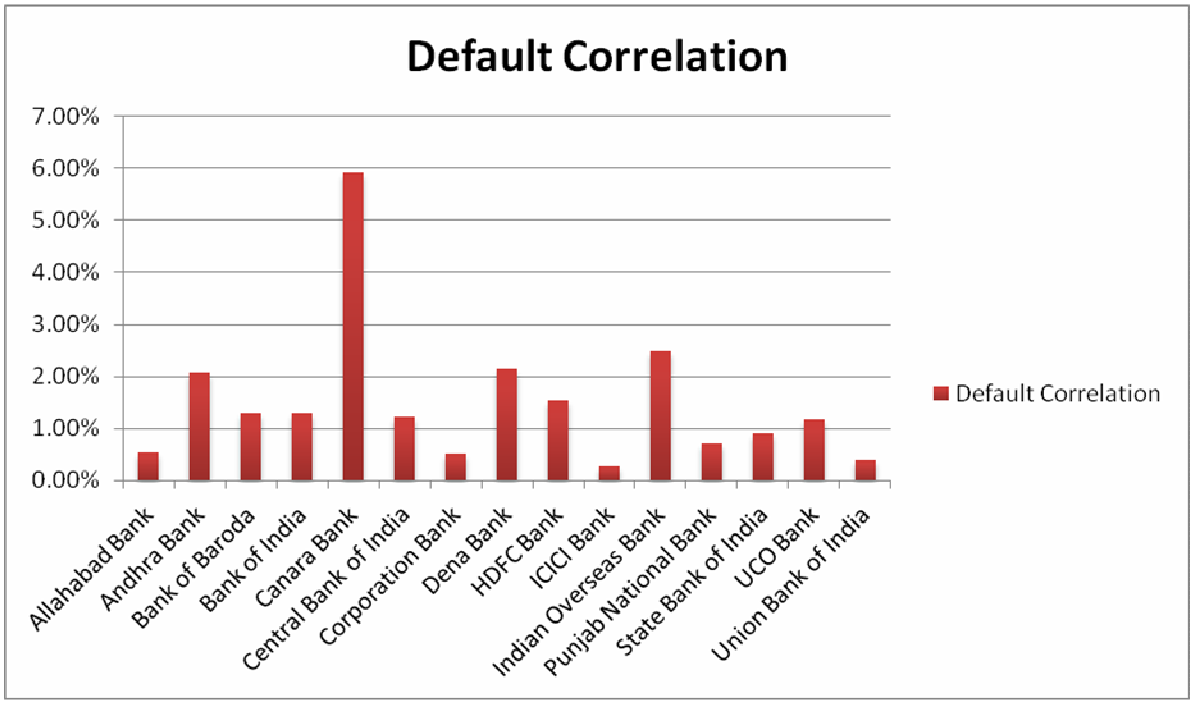
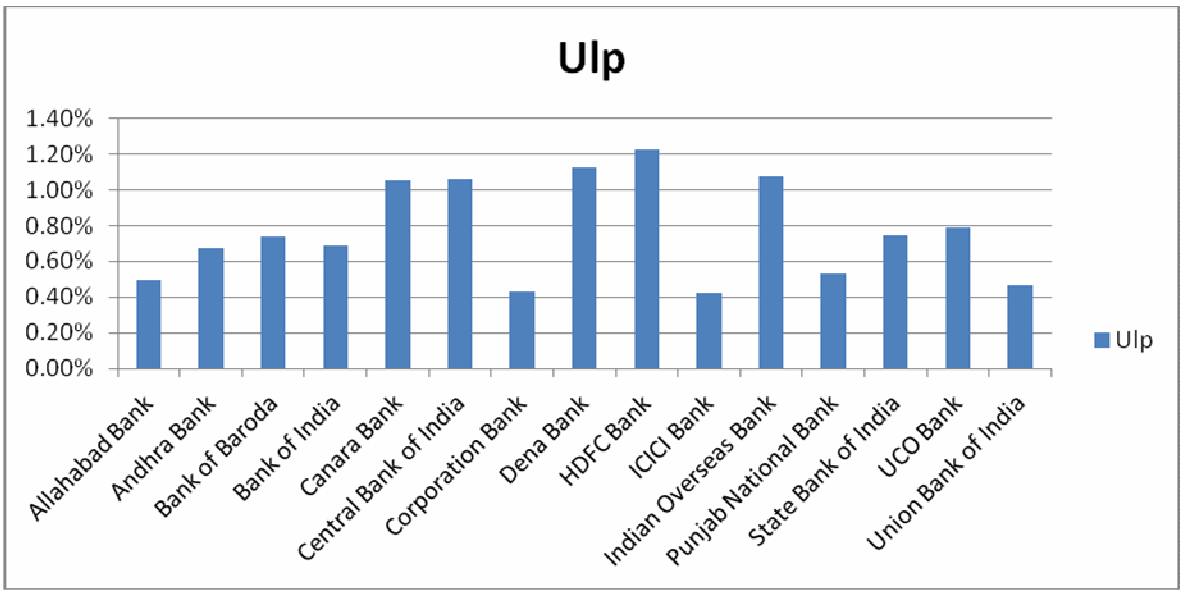


Chart 1

Correlation captures the systematic risk. More granular the portfolio, higher the diversification and thus lower the default correlation. From our data we can say that Canara Bank has the highest default correlation while ICICI has the lowest. This gives us an estimate about the probability of all the loan assets in a particular banks' credit portfolio to default together. This figure is more important during times of downturn.

If we compare the figures of ULp and ULt for each bank, we are able to analyze the correlation better. The default correlation compares the actual unexpected loss of the portfolio (ULp) to the sum of the individual unexpected loss of all the assets in the portfolio (ULt). Due to diversification benefits, ULp is always lower than ULt. Higher the ULp, that means lower the diversification in the portfolio and thus higher the correlation.

Chart 2 compares the ULp and ULt figures of the banks. If we take the example of Canara Bank, the ULt is quite low (4.33%) but the ULp(1.06%) is among the highest in the group of 15 banks. If we compare this with Allahabad Bank, the ULt is very high (6.75%), but the ULp, i.e, the actual UL of the portfolio is among the lowest at 0.49%. this shows that Allahabad Bank has a highly diversified portfolio.



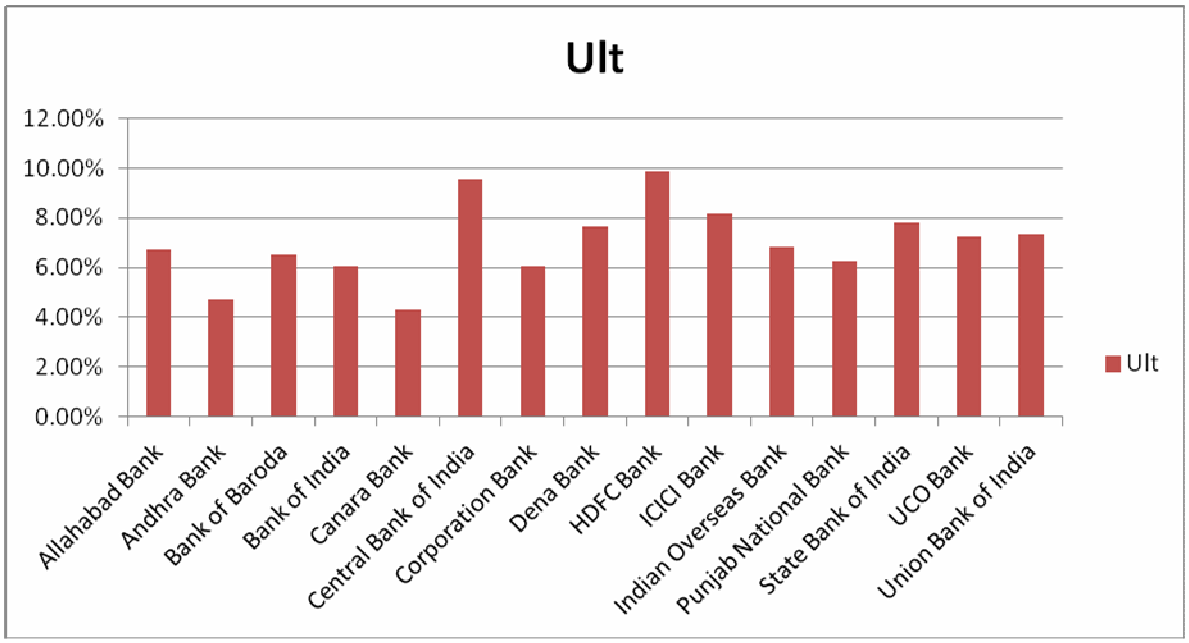


Chart-2

Next, we estimated the default correlation on Moody's one year default rates rating wise. The chart below compares the default correlation with the overall PD for each rating. A general observation here is that the default correlation follows the same trend as that of the overall PD. We find from the data that the overall PD for A category is lower than that of Aa. Similarly, the default correlation too follows the same trend, i.e, it increases with decreasing credit rating but is lower in case of A than that of Aa. That means PD is the main driving force for default correlation, i.e, with increasing PD, default correlation also increases. Chart-3 further elaborates this.

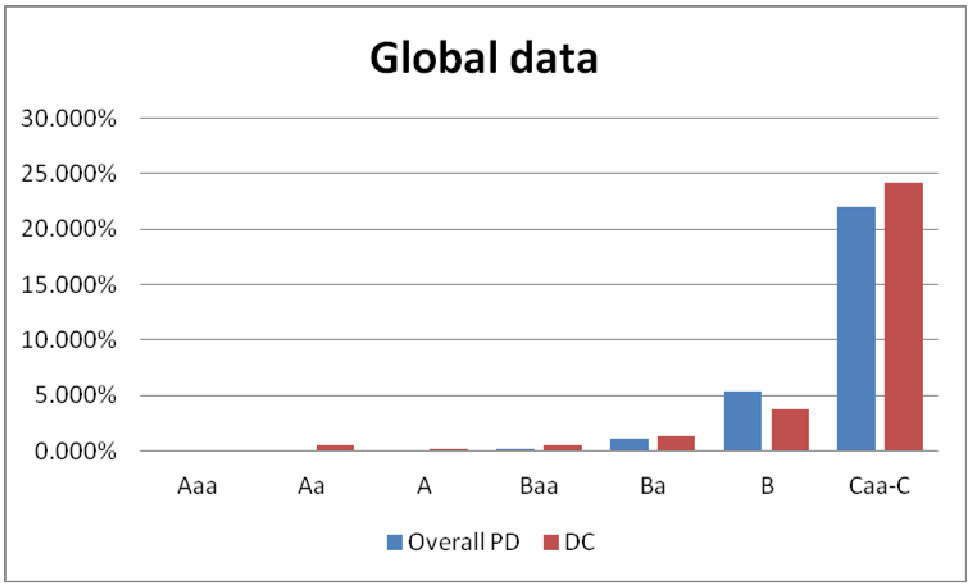


Chart-3

The same trend is seen in Indian corporate (Chart-4). As the rating grade worsens, i.e, the PD increases, the default correlation also increases. Default correlation for B category is shown lower than BB, but this may be due to lack of adequate data.

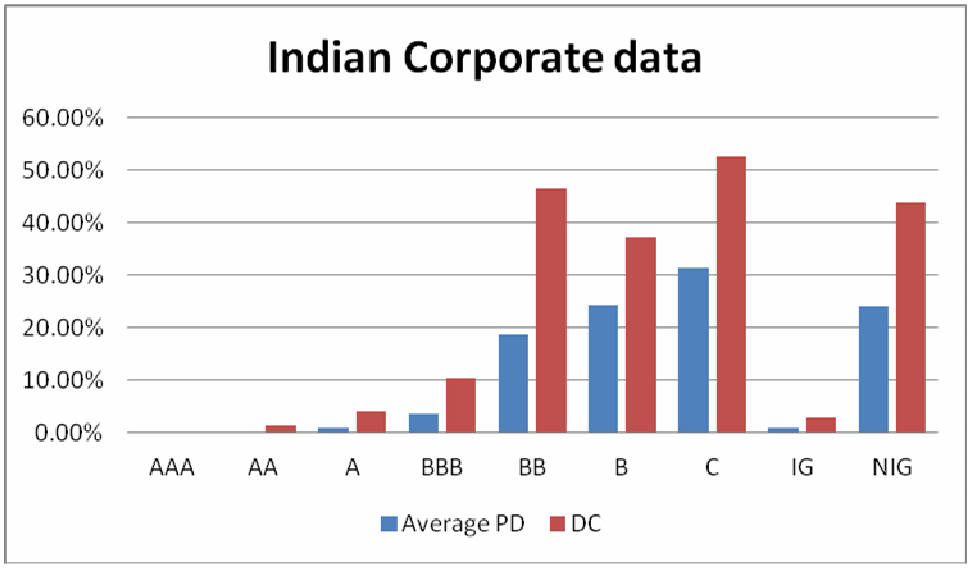


Chart – 4

This result is of significance for Indian banks since it implies that poor credit quality commercial loan portfolios would have to be supported by a higher level of economic capital not just because the default probabilities in such portfolios will be high but also because of higher inherent default correlations between poor credit quality borrowers.

Next we estimate the asset correlation using variance equation. The asset correlation shows how the asset value of one borrower depends on the asset value of another. Likewise it can be described as the dependence of the asset value of a borrower on the general state of the economy.

Asset correlations are also an important component of the Basel II Accord for regulatory capital requirements of credit risk portfolios. In the Basel Committee on Banking Supervision (BCBS) document of June 2006 asset correlations for sovereigns, banks and corporates were principally assumed to be between 12% and 24%, depending on the probability of default (PD) assuming that asset correlation declines with PD percentage. For the lowest PD borrower the asset correlation is 24% and for the highest PD the asset correlation is 12%.We note that for small and medium sized corporates an extra downward firm-size adjustment up to 4% is made and this brings the effective range of corporate asset correlations between 8% and 24%.

Chart-5 shows the asset correlation based on Moody's one-year default rates for a period from 1970-2008. An interesting point to note here is the negative relationship between PD and asset correlation. This finding corroborates what had been stated by the BCBS (2006).

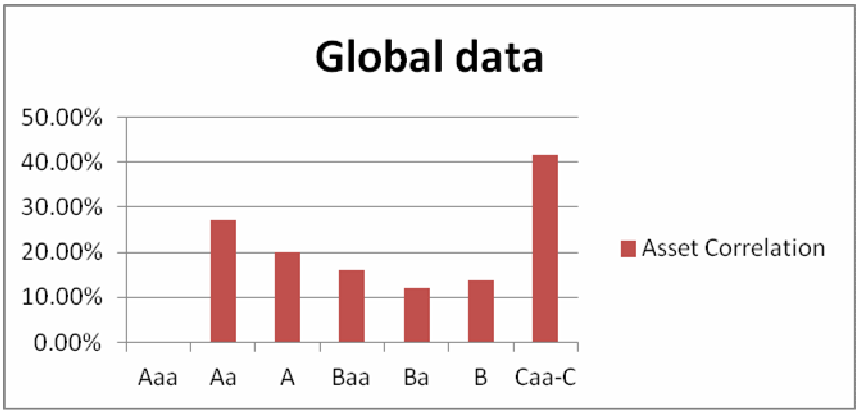
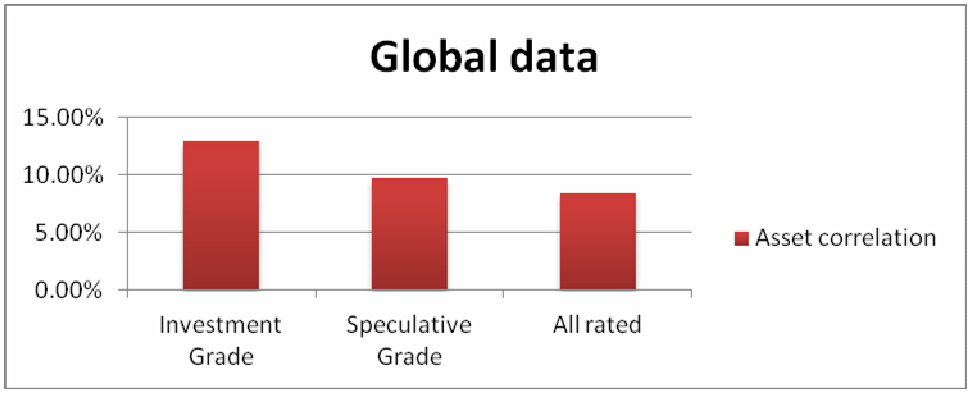


Chart-5

Chart 6 shows that the same trend is followed in case of Investment grade and speculative grade.



An important argument for this negative relation between asset correlation and PD is that, as the firm approaches default, its firm specific risk increases and its systematic risk (given by asset correlation) decreases. However, we did not see the same trend in the Indian corporate data. This may be due to lack of adequate data in India.

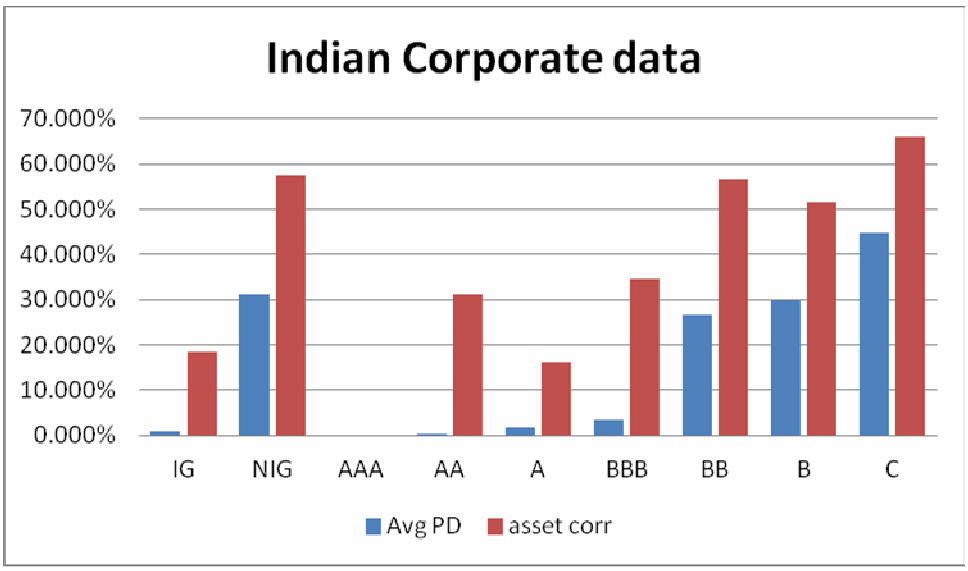


Chart-7

While in case of investment and non-investment grade, the asset correlation increases with increasing PD, there is no particular trend visible in the corporate ratings.

4. Conclusions

The first part of this paper derives the estimates of default correlation in the credit portfolio of Indian banks (public and private sector) and finds its relation to the default probability. The results substantiate the presence of default correlation due to macroeconomic factors and/or macro-economic factors. Since default events are not independent, as is evident from our findings, the correlation effects need to be considered carefully in managing and measuring the concentration risk in credit portfolios.

The second part of the paper deals with the asset correlation figures. There is found to be a negative relationship between asset correlation and the probability of default. This relationship, as prescribed by Basel II IRB document, has been found in the findings based on Moody's data. However, we do not find any smooth relationship between the probability of default (PD) and asset correlation for Indian corporate. The asset correlation range is also different in comparison to what is prescribed for corporate exposures by BCBS (12% to 24%).

These findings have large implications for banks. Asset correlation factor has been included in the Basel II IRB approach for calculation of risk weights. Right now, banks give very little attention to the Pillar II risk, as could be seen from the high default correlation

figures for some banks. However if not taken care of, the correlation risk can prove to be a major reason for losses in downturn.

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